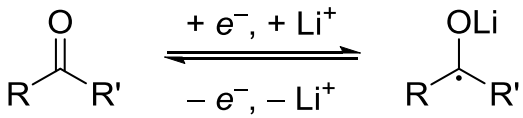
Aqueous Batteries with High-Energy Low-Cost Organic Anodes

TEAM:

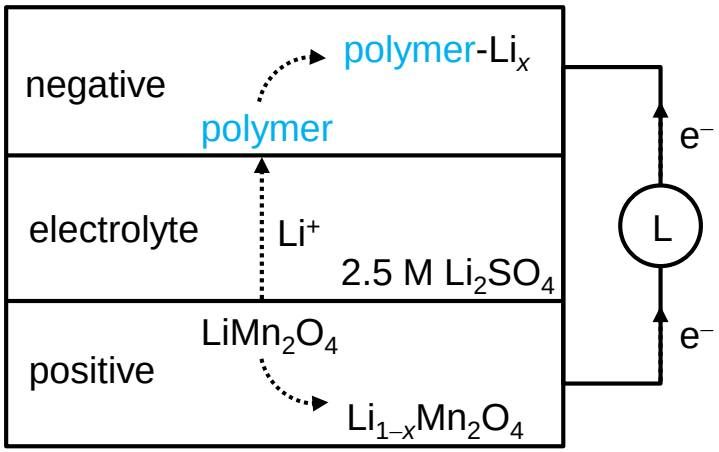
Dr. Yan Yao, Assistant Professor, Univ of Houston
713.743.4432 yyao4@uh.edu
Jeff Xu, co-PI, Southwest Research Institute

Technology Overview

1. Organic polymer anodes enable low-cost and stable aqueous batteries.
2. Materials cost < $125 /kWh, cell energy density 100 Wh/kg, life > 1000 cycles.



UH Aqueous Lithium-Ion Battery



Current Status

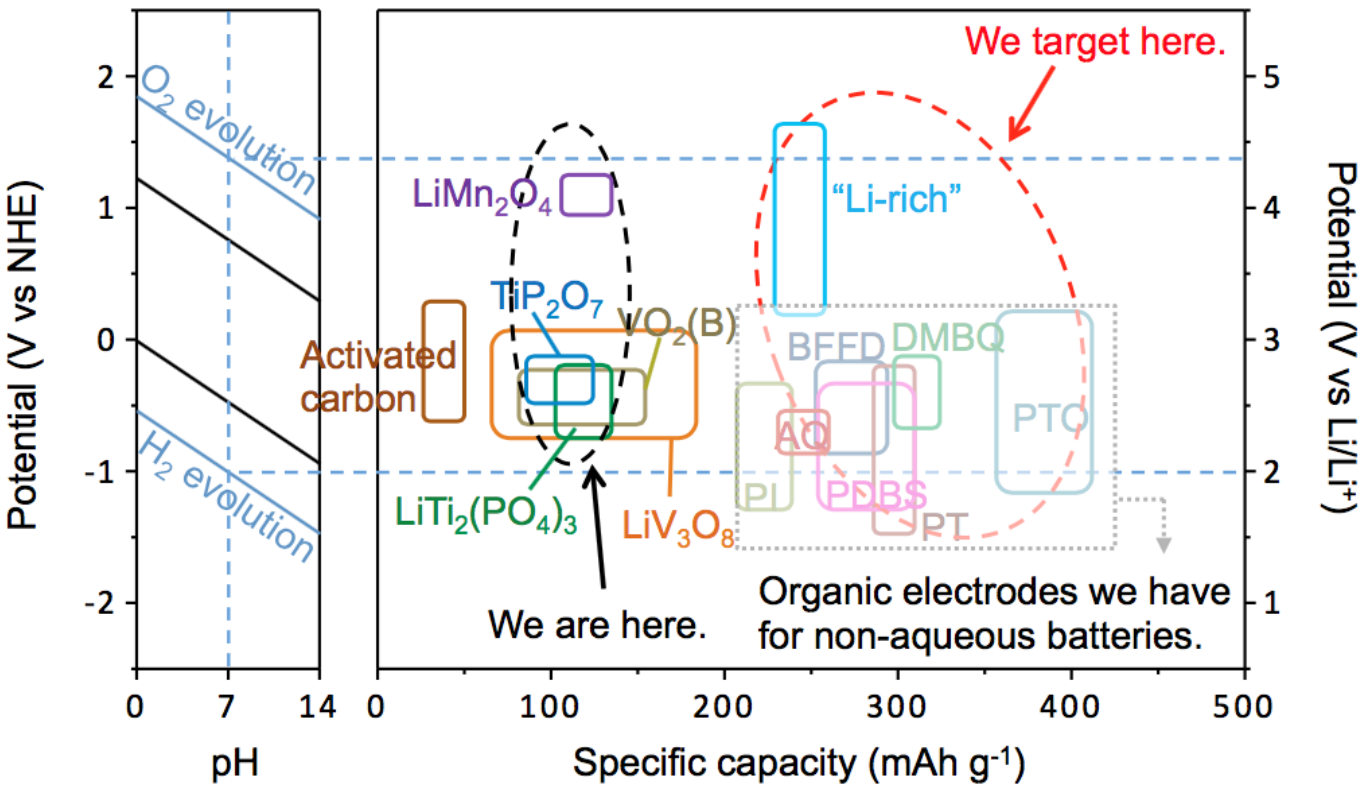
1. Organic polymers have been demonstrated as stable anode materials in aqueous batteries with specific capacities up to 350 mAh/g.
2. Further scale up cells to 2 Ah-level.
3. Estimate cost for full cell and provide block diagram for polymer synthesis.
4. Experts for fabrication of cylindrical/prismatic cells and estimation of polymer cost at large scale.

Project Statistics

Award Amount	$0.96M
Award Timeline	Nov. 2013 – Aug. 2015
Next Stage Target	2 Ah-cell prototype
Collaborations Sought	

DE-AR0000380

Needed: A High Energy & Stable Anode

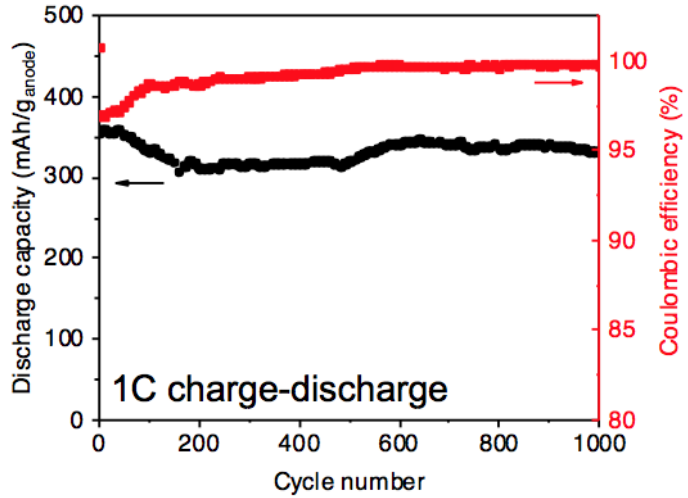


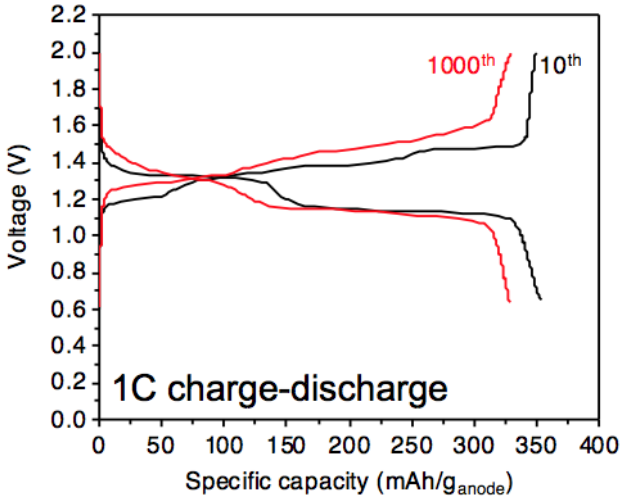
Current art: Stability and high capacity (> 130 mAh/g) are not obtained simultaneously; Very-high capacity (> 200 mAh/g) is not available.

Target: More than double the energy density from the current 60–70 Wh/kg to > 150 Wh/kg by introducing organic anodes.

Performance Characteristics of Organic Anodes

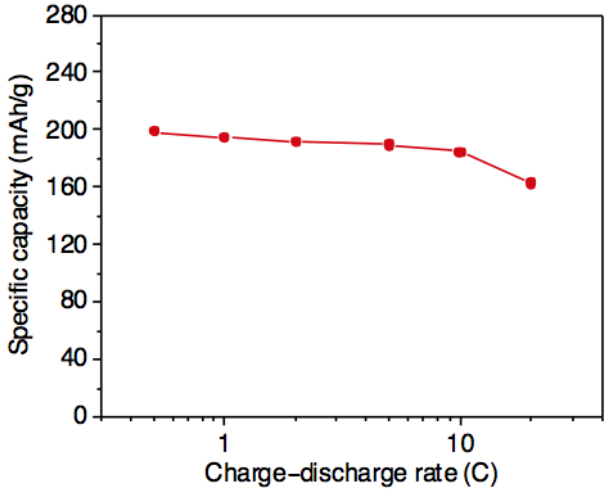
Capacity & Cycling Stability

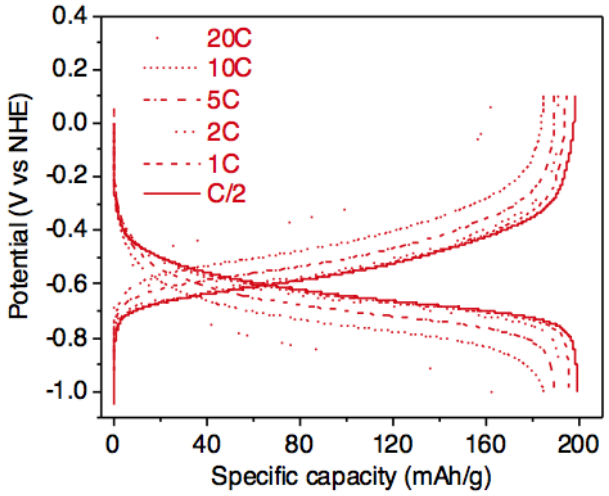




Capacity retention is 93% after 1000 cycles, with stable capacity > 320 mAh/g.

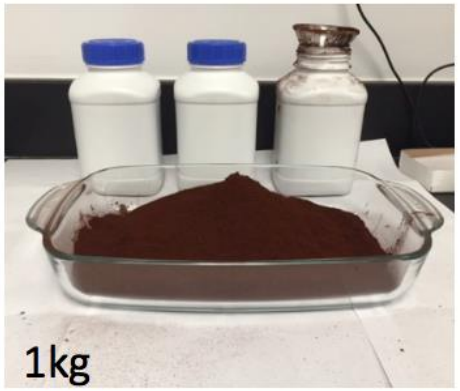
Rate Capability

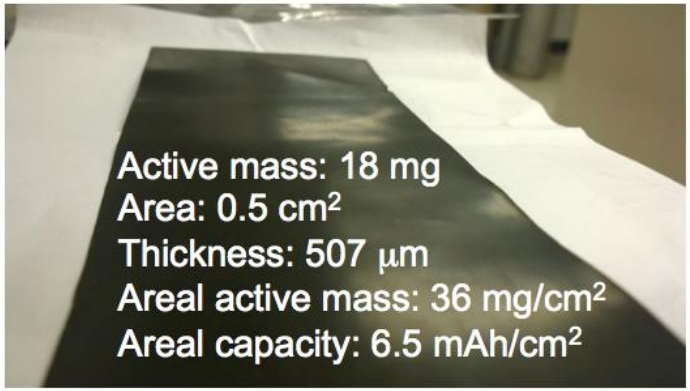


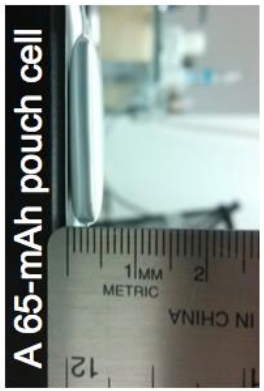


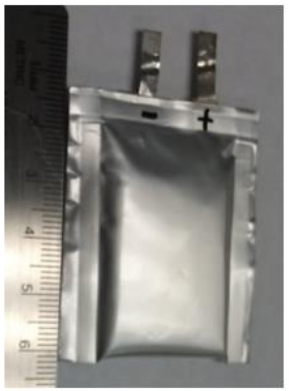
From C/2 to 20C, 82% of the capacity is retained.

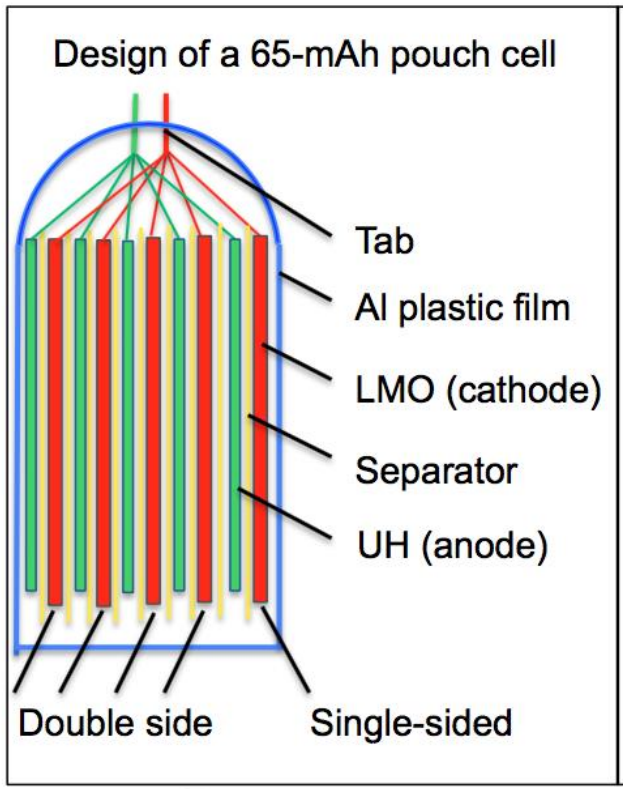
Materials and Cells Scaled Up

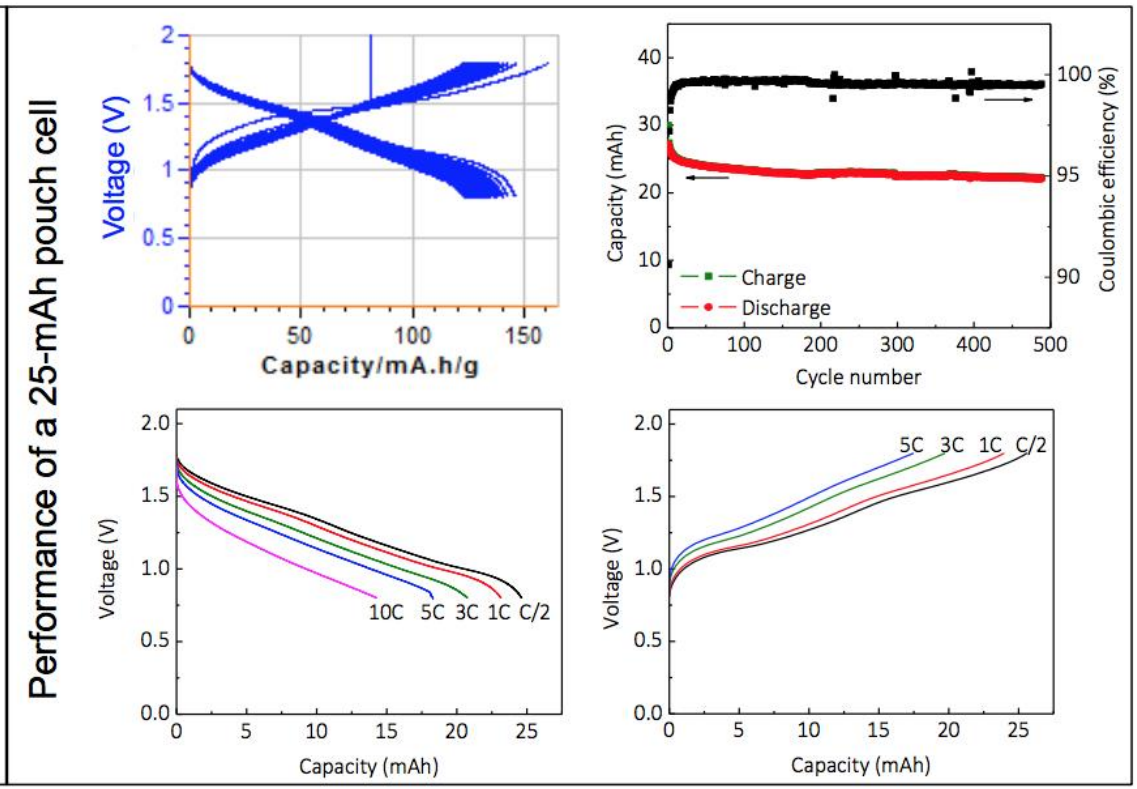












Accomplishments

- We demonstrated that low-cost organic polymers could function as stable anode materials in aqueous batteries.
- We designed, synthesized, and tested over 12 polymers; among them 3 polymers demonstrated excellent capacity, rate capability, stability, and low-temperature performance.
- We scaled up the production of polymers (kilogram-scale) fabricated prototype cells (20-70 mAh) to demonstrate the proof-of-concept.

Lessons Learned

- Polymer-based anodes demonstrate significantly higher capacity, longer cycle life, and better high-rate and low-temperature performance than their inorganic counterparts in aqueous batteries.

Collaborations

- Next-stage task is to further increase cell potential and scale up cells to 2 Ah-level.
- Looking for collaboration in fabrication cylindrical/prismatic cells.